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ABSTRACT

The premise of this paper is that the most important need in education today is the design of an appropriate role for computers and related technologies to profoundly change teacher roles and the structure of the educational system. The discussion describes how teachers can act as central agents for meaningful educational reform. Based on a new technology-based paradigm in which the teacher's role is management of a multiple learning source system, the teacher becomes an information resource and mentor. Advantages of using computer-based technology for educational restructuring include increased planning time for teachers, creation of an active student learning role, individualized learning that eliminates student placement systems, a focus on outcomes rather than input, and increased opportunities for professional growth. Making the restructured system a reality requires a view of schools in their social context, investment of the business sector, and substantial financial commitment. The first steps mandate the full involvement of teachers, leading to professionalization, and public and private collaborative funding. (LMI)

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INTRODUCTION

Advancements in technology have crept into nearly every aspect of society with sometimes profound results. The schools, though slow to assimilate these changes, are no exception. Computers are now present in most schools and many classrooms. Programs, such as IBM's Writing to Read, are being used in Mississippi and the District of Columbia to allow young students to control their own learning through interaction with computers. More recently, the state of Texas approved videodisc software as part of its statewide textbook adoption.

Yet technology's inroads to the classroom are still erratic. Although the potential for radically different methods for teaching and learning is present, the fact is that many teachers and administrators, like most of us, are just barely computer literate. Most educators have not yet comprehended the range of technology's possibilities and implications for instruction.

In "Real Restructuring Through Technology" Eileen M. Ahearn describes how, properly used, technology can be the central agent for meaningful educational reform to the benefit of all learners. Although visionary, this ideal can become reality providing there is an adequate investment in professional development for teachers — along with the political will to change.

Ms. Ahearn is the former superintendent of the Maynard Public Schools in Maynard, Massachusetts. She holds a Ph.D. in educational administration from Boston College.

Real Restructuring Through Technology

by Eileen M. Ahearn

In just about every school in America, a visitor will see at least one computer for student use, and probably a computer lab into which classes of students are scheduled each week. However, the presence of these sophisticated machines does not mean that methods of instruction or the structure of the educational system has been modernized. Critics of the American system insist that the opposite is true — education in America has not changed in any meaningful way in a half century despite increasing pressure for improvement.

What should the role of computers and related technology be in American elementary and secondary education? I will attempt to answer this question by first reviewing the current status of technology use in schools and then presenting a vision of how technology could be the cornerstone for changes that may be the only hope for a viable public education system in the next century.

Conditions in America's Schools of the Nineties

For the past decade, the American educational system has been characterized as ineffective, outmoded, and moribund. It is an understatement to say that public education has exhibited an immense resistance to change. And yet, despite unabated public outcry over the situation, a worrisome decline in student performance has not been reversed. In fact, there is a growing sense of despair about the ability of large numbers of American youngsters to be successful in the next century. The continued intensity of criticism does not mean that there was no response from educators or the public. On the contrary, there have been tidal waves of reform efforts in the past decade. From the smallest to the largest school district, task forces were formed to study the issues and make changes. Earliest efforts concentrated on increasing what the system already required — more homework, longer hours, added courses, and more testing were common recommendations. More recent initiatives have adopted broader approaches and used terms such as empowerment, reform, and restructuring, which indicate their aim to revise the system. While well-intended, the strategies employed in these attempts have proved to be inadequate. The problems persist to a great degree because the proposed solutions have treated the symptoms but neglected to realize the real nature of the illness.

While the education system has remained more or less stagnant, the American economic system has changed dramatically. The basis of a large proportion of economic activity now involves the manipulation of information, and developments in the use of technology have changed the array of skills that the successful adult must possess. Technology has transformed the way of life in all businesses and, indeed, in many areas of society at large as well. Robert Reich in his article, "Education and the Next Economy" prepared for the National Education Association, clearly describes the challenge to education:

> The old system of education mirrored the old organization of production: Most people spent eight to twelve years of their childhood training for cog jobs, while a few were propelled toward top policy and planning positions. The new system must prepare far more people to take responsibility for their continuing education and to collaborate with one another so that their combined skills and insights add up to something more than the sum of their individual parts.

To date, proposed solutions have treated the symptoms but neglected the real nature of the illness.

An educational system that will provide these new outcomes cannot evolve by making minor changes to the existing model. Some effective measures currently used such as school/business partnerships, cooperative-learning methods, and other improved teaching strategies will have a place in the educational system of the twenty-first century; but the basic structure of that system must be essentially different from the existing one. The "points of light" appearing across the country may be real improvements, but an accumulation of small victories will not win this war. It is no longer adequate to provide an education of high quality to a small percentage of students and neglect the needs of the majority. Yet the current basic structure of schools cannot provide the quality of education or the equality of opportunity that is now recognized as critical for the education of this generation of students.

Technology in America's Schools of the Nineties

The education community has enthusiastically embraced, and then rapidly rejected nearly every innovation introduced in recent years. Each new device — the tape recorder, educational television, and a variety of learning machines — was soon relegated to the book closet or used sporadically for show.

For the most part, the introduction of computers and related technology has suffered the same fate because the new technology has been added to the existing classroom as just another fancy novelty. There has been only limited realization of the full potential of the computer, while even newer forms of technology are being developed and applied not only in the business sector but in society at large. The computer has been used in the classroom more as an electronic workbook for drill and practice than anything else. Very few schools are taking advantage of the computer's unique features that separate it from all other educational fads. The computer is an interactive tool capable of providing immediate feedback, reinforcement, and spaced review of learned material. It also has a demonstrated capacity to motivate children, a feature that has fostered its misuse as a mere reward for the completion of paper-and-pencil tasks. But even in schools where the computer is being used to enhance instruction in a meaningful way, it is only experimental and viewed as something separate from the "real" curriculum.

The most important need in education today is the design of an appropriate role for the computer and related technologies in education: it can and, as this article will argue, it *must* be used to bring profound changes to the role of the teacher and to the structure of our system of public education.

The Potential Role of Technology in Education

The way in which students are taught is the nucleus of all the problems in today's classrooms: for the most part, the teacher is active and the students are passive. In the self-contained classrooms of the early grade levels, teachers plan lessons for the whole class or for a particular subsection such as a reading or math group. The teacher then provides direct instruction in a concept or skill area designed to build on the estimated achievement level of the majority of students in the group. Subsequently, the students work independently on "seat work," usually paper-and-pencil tasks sometimes differentiated according to students' abilities, but always meant to reinforce the content of the teacher's lesson. The teacher then attends to another subgroup for direct instruction and the remainder of the class must wait until that session is over before asking questions or receiving feedback on their work. Too often, it will be time for recess, lunch, or some special event before any of the students can ask for help, leaving the unfinished and/or incorrect work of the student to be picked up again the next day. At the secondary level, the role of the student is even more passive. Many teachers continue as they were trained to use lecture as the mode of instruction. They expect students to take notes which, in addition to the textbook, represent the total curriculum of a course. Occasionally in a lab or social science course, opportunities for hands-on experience is incorporated into the curriculum, but usually such activities are add-ons or special demonstrations. Even in mathematics courses, the teacher's activity predominates. Students are expected to pay attention — almost always as a total class group — and then to apply the explained procedure in a homework assignment to be reviewed and corrected during the next day's class.

Elementary and secondary teachers must spend large amounts of time planning lessons and keeping track of student progress. The constant complaint that there is not enough planning time is a reflection of the real pressure teachers are under trying to manage an approach that was adequate when the amount of available knowledge was limited and the majority of students would not need more than a low level of literacy. Much attention has recently been given to new or updated techniques being adopted to address these inadequacies. Teachers have reached out to adopt approaches such as cooperative learning, writing as a process, and integrated projects to involve students in a more active role in their learning. And, of course, the introduction of the computer into the classroom has made some dramatic differences where it has been applied to meaningful instructional changes. However, the effect of these innovations has been superficial because there has been no structural change to accommodate the explosion of information and the need for greater skill at solving problems and reasoning. In addition, the computer's present role has been inadequately implemented because of inappropriate software, limited resources to acquire hardware, and scant attention to teacher-training. This powerful machine has been relegated to a minor role in drill and practice, isolated learning games, or reward activities.

New technologies can and must be used to bring profound changes to teaching and to schools' structure.

This dismal portrait, however, could change completely if the computer were incorporated in a manner designed to take advantage of its potential. Recent experiments with computer-based integrated learning systems (ILS) hint at the possibilities. With ILS, there is no need for grouping in basic instruction. Students progress at their own pace in the basics with immediate feedback throughout the instructional process. An approach such as ILS also eliminates the struggle to design lessons that reach the nonexistent "average level" of a class or group of students. And yet, even this exciting innovation is doomed to failure if it is merely an appendage to the educational system as it is structured at present. Schools in which ILS is currently being tried have been treating it as an experiment and isolating it in a lab where a specially trained teacher directs the students' activities as an add-on to the "regular" curriculum. Without integration into the curriculum and, most important of all, adequate training for classroom teachers in its use, a technology-based approach will have little impact on learning. The computer and related technologies could also be the basis for radical change in the way students acquire concepts and skills beyond the basics. For example, in many middle schools, students are using modems to connect their computers across telephone

lines with the computers of other students and professional scientists. Together, these groups work on finding solutions for real problems that affect the whole planet such as the disruption of the ozone layer or the disposal of solid waste. Students work in pairs or small groups to gather data on the current conditions, they research the development of the problem, they review unsuccessful solutions, they develop hypotheses for new solutions, and then they devise simulations to test their hypotheses. Using existing technologies such as the computer, the modem, major databases, and electronic bulletin boards, these students can have immediate access to information, as well as be in direct communication with professional scientists working on real-life problems. In this and similar activities, students learn to work cooperatively in attacking a problem, they develop their ability to think critically, and they learn to solve problems through meaningful exercise.

Newer technologies will soon place the entire accumulated knowledge of human experience at students' fingertips.

Newer technologies such as CD ROM and videodiscs will soon place the entire accumulated knowledge of the human experience at a student's fingertips and improved databases will dwarf currently available information resources. For example, it will be routine in the not too distant future for a school library to have a complete copy of the Library of Congress among other extensive indexes. The major activity in schools — for staff and students — will be learning how to learn. Accessing and using information is already an essential skill; technology will only continue to expand its importance.

This brief summary of experiments being conducted in schools today suggests the magnitude of change that could occur in the schooling of our next generation through the application of technology. Could the answer to America's educational problems be merely an infusion of funds to provide equipment to adopt newer technologies into the schools? Probably not. Major theorists in education are coming to see that a complete restructuring of the entire system is the only real solution.

What is Real Restructuring?

One of the hottest topics in the educational literature today is restructuring and the most common activity undertaken in its name is school-based management. Sometimes this means only the assignment of budget responsibility to a principal, or it may be a change as drastic as the Chicago experiment in which governance councils composed

of school and community members take over responsibility for many of the management functions in the schools.

However, that is not what is meant by restructuring when that word is used by educational theorists such as Robert K. Branson of Florida State University. In the *Journal of Instructional Development* in 1987, Professor Branson presented his assessment of the conditions in American education in his article, "Why the Schools Can't Improve: The Upper Limit Hypothesis." Branson maintains that the current structure of schools has reached about 98% of its potential maximum of productivity, and that any addition could bring only negligible change. He describes the current American educational system as one that was never based on a conceptual design, but rather one that evolved from ancient practice designed to fit small, primitive settings. The model was

The schools have reached 98% of potential maximum of productivity; any addition could bring only negligible change.

improved over time, but there is no further improvement that could significantly change outcomes if there is no restructuring. According to Branson, education is the only sector of the society which has not incorporated technology to meet the demands for improved output. He recommends that the entire educational establishment go through a redesign to define mission and system requirements and then build a system based on those factors. With support from Andersen Consulting in Hartford, Connecticut, Branson is developing the conceptual specifications for School Year 2000, a plan to put into practice his recommendations for a radical redesign of the American educational system. As private industry has learned, there is no substitute for functional system design that is based on a complete analysis of the task to be achieved, development of a consensus on the mission of the organization that will reach toward those outcomes, and then implementation of the necessary structure to realize that vision. The process cannot be shortened for a quick fix. Continued bandaids applied to the educational system will invariably result in handwringing such as we now see because the flaw exists not in any one component, but in the design of the educational system as a whole.

A New Paradigm

Branson contrasts three educational paradigms. First, in ancient times, which he calls the oral tradition model, the teacher was the center of focus as the one to impart knowledge and experience to students. It was a one-way flow: the teacher acquired

information and transmitted it to the student. This model sufficed for education as long as the knowledge-base was limited and transmitted verbally. With the expansion of knowledge and the development of supplementary sources, such as books and other media, the current educational paradigm evolved. The teacher is still the major dispenser of knowledge, but there is a wider use of auxiliary sources and the model allows for some interaction among students depending on the specific techniques the teacher has been trained to use.

Branson proposes a new technology-based paradigm for the future in which the teacher's role is to manage a system in which there are multiple sources for students' learning. The center of the paradigm is a computerized knowledge database and expert systems. The teacher and students all interact with that core as well as with each other, learning from any one or more of these sources. The teacher no longer needs to present information directly to students, but rather directs, plans, and monitors students' learning in conjunction with other staff and also learns along with the students.

The revised role for teachers is a crucial component in this new design. The teacher will function much like an orchestra leader conducting individuals and the group to be more than they can be alone or in unison. Preparation for this kind of teacher will be different from traditional teacher education. Teachers will continue to need a solid base in liberal arts, but they will also need to develop expertise in accessing information and in ways to train students to use and manage our dramatically expanding information base. No longer will teachers be the source of information for students as their traditional role required. Rather, they will be for students a resource in finding and using information, in applying technologies to assess the value of that information and in strategies for using that information to solve problems. Teacher preparation must

In a new technology-based paradigm, teachers manage a system in which there are multiple sources for learning.

be revised in order for prospective teachers to be able to encourage students to be proactive in their own learning, and also to strengthen teachers' ability to work with other educational professionals in the planning and management of students' learning. The new role will be a more professional one that will allow for the application of the full range of a teacher's creativity now stifled by the need for repetitive presentations. Planning will be a major responsibility and teachers will be able to benefit from continuous professional growth through contact with each other, a rare luxury in the current design of schools.

Many of the current difficult problems such as tracking, grade placement, and special treatment for the gifted and talented will disappear as issues in the new plan for schools. The emphasis in education will shift from a focus on inputs — teacher activity, class placements, textbook selection, and the like — to outcomes. That is, the educational system will be driven by what a student is expected to know and be able to do. The basic curriculum will be translated into computer-monitored segments through which students move developmentally. The sophistication of a computer program will allow each student to progress at an appropriate rate either branching for repetition and representation of a lesson, or moving on to another concept once the student demonstrates mastery. The computer will keep the teacher informed on the exact status of each student's needs and achievement, allowing the teacher to intervene if necessary, to

Current problems such as tracking, grade placement, and special treatment for the gifted, will disappear as issues.

pair students with similar needs to help each other, or to plan activities for enrichment that will expand students' understanding. Students will progress at their own pace in the acquisition of the basics, and will be involved in projects that are timed appropriately for optimal learning and closely monitored by teachers. Grouping will be flexible and determined on the basis of educational need rather than chronological age or bureaucratic necessity.

Goals so long beyond our reach, such as true individualization, will be accomplished through the very nature of the new system design. Volumes have been written about strategies to achieve individualization in the current school structure, but it is an impossible goal as long as there are restrictions imposed by grade structure and teacher-initiated instruction. Under the new structure, children will never have to "catch up" with their class, nor will they have to wait until others catch up with them before they can advance.

Schools of the Twenty-first Century

Establishing a restructured school system based on a paradigm such as the one just described requires a shared vision of what education could and should be for students of the year 2000 and beyond. While specifics will be developed during the process of design, educators and the public at large must begin to develop that vision immediately. Perhaps the following brief scenario of a school day in the future can help to frame that vision.

It is 2010, and eight-year-old Bobby arrives at school at 10:00 a.m., late because he has just returned from a trip with his family. He checks in at the office where he is welcomed back, and then goes to the assignment computer station to reconnect with the educational program stored for him by his mentor teacher. There, Bobby logs on and sees a proposed schedule for the day that includes a review of the math and reading skills he was working on two weeks ago, and a list of integrated projects he can join that are centered around science and social studies with component strands that incorporate the arts. Bobby sets up a schedule that includes an hour in basic skills, a computer introduction to the spaceship-building project that he will join at 11:00 a.m. with four other students, and a 1:00 p.m. meeting with a ten-year-old friend who is about to start a project on how a law gets passed in their city government. The computer approves his schedule and his mentor teacher, who is responsible for monitoring his total learning program, gets immediate notification at his computer terminal. Bobby is now responsible for following his schedule. His activity is tracked as he moves about the building using computers in the math room and the reading area. At 11:00 a.m. Bobby joins a teacher, Mr. Jones, and four other students on the spaceship project where they discuss how they will start to build a miniature replication of a space station. Mr. Jones guides this planning session. He helps the group begin a list of materials and ways in which they can determine how much of each item will be needed to meet the specifications they learned about in the computer introduction to space travel that was viewed earlier. Mr. Jones will later meet with the mentor teachers for these students to monitor each child's experience in meeting the predetermined learning goals set by the planning group. After a break for lunch, Bobby goes to the library where Mrs. Smith helps him and his friend locate the videodisc resource on their city's existing laws.

Children will never have to 'catch up' with their class, or wait for others to catch up with them.

The two boys have difficulty on how to go about learning how a law gets passed, so they contact a government resources student from the high school by computer and make an agreement to meet with him the next day to talk about the way the older student handled a similar project when he was in elementary school. It is now 3 o'clock and Bobby joins his soccer team for a practice session. He will end his day at 5:30 p.m. when his mother comes to the school to pick him up. When they get home, Bobby's mother can use their home computer to access Bobby's school program to see if there are any notes from the school for her and to check on Bobby's progress and decide whether she needs to discuss any part of it with Bobby's mentor teacher.

An educational system that could provide a school day like the one just described would have as its major feature the appropriate integration of technology into the process of learning. There would be no need for rigid class periods throughout the entire day. Students would be allowed to progress at their own pace with mastery being the objective – not the amount of instructional time. Testing would be constant and a far cry from the traumatic, periodic burden most children experience in schools today. Computer programs would contain checks on learning as an integral part of the activities, and such "tests" would be a routine part of learning. The computerization of basic skills instruction would also permit well-spaced review of previously learned material to assure complete mastery. With this programmed evaluation of the basics, teachers would be free to concentrate on using other types of assessments such as performances, productions, and portfolios of student work to provide more accurate and complete records of students' progress. Children would attend a school based on developmentally appropriate age groupings, but the traditional grade divisions would not be a part of the structure. The school would be organized into learning spaces for individual, group, or schoolwide activities to encourage flexibility and support an integrated approach.

In this school of the future, teachers would act as mentors and could focus on planning for students using a fully integrated curriculum. No longer would students have to stop a math lesson to meet with the art or music teacher, nor would any one curriculum area be taught as an isolated entity. Computer-generated, continuous progress records for each student would be available to the faculty allowing for the revision of a student's program based upon past performance. Such resources would also make it possible for teachers to assign students to projects based on meaningful criteria such as individual learning needs, maturity, and interests rather than grade level or chronological age.

If John Dewey returned to life, he would find little that was different than when he worked to make schools meaningful.

All of the technology needed to make this classroom of the future a reality already exists today, and there are experiments currently ongoing to test various components of it. The new statewide revamping of the Kentucky public schools mandated by court order includes extended use of technology and progress toward the elimination of the archaic grade structure system with ungraded kindergarten through grade three classes. Even more exciting is the new Westridge School of the Future in Greece, New York,

an extensive experiment encompassing many of the elements of the new paradigm. Not too long ago, the school had been closed and turned into a community center. When added space was needed for students, the school system entered into a partnership with a local developer to renovate the building, allowing for its use as a school and including space for the developer to lease as payment for the project. The staff was selected a year in advance of the opening of the school and, through a partnership agreement with NYNEX and IBM, the school was planned with technology and a changed role of teachers as the cornerstones. The school opened in September 1990, and the teachers are focusing on writing learning outcomes as guarantees for students who are organized by assignment to family groups — kindergarten to grade two, and grades three through five. Although there is no fully planned technology-based curriculum available to them, the Greece, New York experiment could be a first step in this direction, and it will be studied closely as a pilot test of many of the components of a restructured system.

Making the Restructured School a Reality

The *sine qua non* for a restructured public school system is a shared vision upon which a new mission can be built. The schools must be viewed in their social context and the development of the schools' mission must necessarily take into account the changed structure of the American family and the needs of the whole child. Considerations such as flexible hours, wrap-around services to incorporate the delivery of human services in the school setting, and adding developmentally appropriate programs for much younger children, all deserve serious consideration in the revision of the educational system. The investment of the business sector will be crucial both in terms of funds and technical assistance in the redesigning. The school/business/community partnership will be the basis for success in what will probably have to be at least a ten-year venture to restructure the American school system.

There will be, of course, a big price tag on restructuring. However, the present lack of academic improvement despite large investments of public and private funds calls for drastic measures. There will be costs for hardware, extensive software development, teacher-training, and expansion of the educational program. Yet, with no real structural change, education costs will continue to grow and, over time, the continued poor performance of schools will actually result in even higher costs.

We cannot be content with limited experimentation or expect the system to change without drastic measures. There is a preponderance of "sacred cows" in education such as grade levels, forty-five minute periods, reading groups, and the like. They are supported with religious fervor in "save our schools" campaigns, and they have successfully blocked any meaningful restructuring in most schools. Education should take a lesson from the automobile industry which agonized over technologically forced changes. Workers learned that they had to alter their role and give up parts of their old jobs to continue to exist in a changed economic environment. The changes pervade all

aspects of society. Public education cannot stand still or make superficial changes and expect to continue to exist. The current archaic conditions in the schools are illustrated by a popular comparison: if Thomas Edison returned to earth today, he would be amazed at the changes his discoveries have brought; similarly, the Wright brothers would probably be dumbstruck at the advances in air travel since their first success; but, if John Dewey returned to life, he would find little that was different in American education since the days he worked so hard to make schools relevant to students' lives.

First Steps/Next Steps

There is nothing to be gained by trying to decide who is to blame for the current state of American education — no individual or group owns the problem. Change is painful and education as an institution is inherently resistant to change. There have been so many short-lived fads that it is reasonable to expect teachers to continue in their set ways waiting for this, too, to pass. Therefore, the first step in the real restructuring of schools is the full involvement of teachers in the development of their new role and the design of the classroom that can be. Such involvement will be the beginning of a long-overdue professionalization of the teaching corps, a necessary basic component to the continuation of a viable public education system in this country.

Although the needs of the economy are not the only driving force for our educational system, private industry has experienced most of the types of changes that education must now undergo. The traditional underinvestment in educational research and development must be reversed in order to adapt available technology to maximum use for the school setting. Clearly, this is a major funding issue that will require the participation of public and private sources working together. There is no alternative to a significant investment if we are to come anywhere near reaching the goal of providing an education appropriate for life in the next century to all children on an equal basis.

The underlying force that will drive this movement is a national vision of what education can and should be, and the commitment of the resources to implement that vision. The time is running out for taking the steps to make these visions a reality. We have the tools, but we cannot use them without creating the setting that will take advantage of their power. We need a national consensus to launch an effort of the magnitude of the 1960's commitment to put a man on the moon in that decade. The need is great, the time is far overdue, and the tools are at hand to change the structure of American education to meet the needs of today's students who will live their adult lives in the next century. We owe them the investment to make the education they need a reality.

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